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NOTICES.

DARTONFIELD ESTATE—VISITORS' DAYS

The *second* and *fourth* Wednesdays in each month have been set aside as Visitors' Days at Dartonfield Estate, and the services of all Technical Officers will be available to visitors on those days. The Estate Superintendent will be available every Wednesday. Visitors are requested to arrive on the Estate not later than 9-30 a.m.

While visitors will be welcomed at the Station on other days, any particular member of the Staff may not be free to give them attention unless an appointment has been made.

Dartonfield Estate is situated about $3\frac{1}{2}$ miles from the main Matugama-Agalawatte Road, the turn-off being near culvert No. 14/10. The distance from Colombo is approximately 45 miles.

INDENTIFICATION OF CLONES

The attention of Proprietors and Superintendents undertaking replanting or budgrafting programmes is drawn to Planting Manual No. 5: "The History and Description of Clones of *Hevea Braziliensis*" issued by the Rubber Research Institute of Malaya, copies of which may be purchased on application to these Laboratories for Rs. 5-00 each (postage free.) This publication gives drawings and descriptive particulars of the more important clones, which should enable Superintendents to verify the authenticity of their material.

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ORIGINAL ARTICLES

MEETINGS ETC.

REPLANTING OF RUBBER*

R. K. S. MURRAY,
BOTANIST AND MYCOLOGIST

ONE of the most striking characteristics of any crop raised from seedlings of mixed origin is the pronounced degree of variability amongst the individual plants, and when such a crop becomes the subject of scientific study it is not long before the plant-breeder is able to turn this variation to practical account by producing strains which are particularly desirable from an economic standpoint, as regards either quantity or quality of the finished product. Rubber is no exception to this rule, but whereas with annual crops it is a simple matter for the farmer to plant the more desirable types in exclusion to the less desirable without incurring any additional expenditure in so doing, in the case of "permanent" crops, such as Rubber, Tea and Coconuts the commercial exploitation of the plant-breeder's work involves the extension or replacement of existing plantations. Under the terms of the Rubber Regulation Scheme the planting of new land is prohibited, but replanting of areas already under standing Rubber is permitted up to a maximum of 20 per cent. of the total acreage. At present, therefore, replanting — or "rejuvenation" as it is sometimes less appropriately termed — offers the only means of using improved planting material on mature estates. What are the advantages to be gained by the possession of such material ?

The great majority of Ceylon estates were planted before any selection work had been undertaken, and the trees comprise, perforce, a mixed population of high and low-yielding individuals of which the latter predominate. A few estates have removed their least productive trees to the benefit of those that remain, but the extent to which selection can be carried out by such means is clearly very limited, and it would probably be true to say that 50 per cent. of the average estate's crop is given by about 25 per cent. of the total number of trees. It has been shown beyond the possibility of doubt that the factor of high-yielding capacity is inherent in the tree, and the great majority of

* Reprint of an article contributed to *The Times of Ceylon.* (Certain figures have been slightly amended).

seedling trees are constitutionally incapable of giving high yields, as judged by modern standards, whatever treatment they may be given. For example, by examining nearly 4½ million individual seedling trees in Sumatra, Grantham found that only ·3 per cent. gave a yield equal to that of a first-class clone. It is, therefore, abundantly clear that the "ceiling" of yield of the ordinary plantation is fixed at a relatively low level, and we know from experience that whatever cultivation measures are adopted it is very rare for annual crops to approach the 1,000-lb. per acre level. The problem with which most estates are faced is to prevent the yield falling below 400 or 500 lbs. per acre.

The selection and breeding of high-yielding strains of *Hevea* has developed most rapidly in the direction of vegetative propagation by budgrafting. Research on genetical lines has proceeded concurrently, but such work is necessarily much slower in producing tangible results and for all practical purposes we in Ceylon are at present limited to the use of budgrafts of clones proved in the various producing countries. A detailed consideration of the yielding capacity of the various proved clones is outside the scope of this article, and it must suffice to state that comparisons in various countries have shown that the ratio of yield of the best clones to that of unselected seedlings grown under the same conditions is about 2½ to 1. Large areas of budgrafts are now in commercial tapping, and most of the yields are of the order of 1,000 lbs. per acre at 9 or 10 years old. Younger clearings planted with newer clones are expected to do even better, and there is no doubt that yields of 1,500 lbs. per acre at full maturity will not be exceptional. The fears expressed in the early days of budgrafting that the high yield would prove to be only a temporary phenomenon, that the bark would not renew normally and that the grafts would be unduly susceptible to diseases have not, in general, been fulfilled, and if clones are selected with an eye to secondary characteristics as well as to yielding capacity the danger of the material proving unsatisfactory is reduced to a minimum.

In the light of the above considerations we are in a position to answer the question raised in the first paragraph: "What are the advantages to be gained by the possession of improved planting material ?" The profit-earning capacity of any Rubber holding is dependent on three variables: (1) the price of the commodity, (2) the yield per acre and (3) the cost of production The future price of rubber cannot be foreseen and is

largely beyond the control of the producer, but the other two factors are directly dependent on the efficiency of the planting material. Whatever the future may hold in store it is the modernised, high-yielding estates which will be best able to cope with the situation. When the price of rubber is high they will be able to make bigger profits: when it is low they will be in a position to avoid losses. The present scheme of regulated supplies and restricted planting has prolonged the life of our old estates and is affording the opportunity for the rationalisation of the industry. An essential item in any programme of rationalisation is the substitution of potentially high-yielding material for our present inefficient and often decadent trees.

The relation between yield and race — or breed — has been given special emphasis as it constitutes the main reason for replanting. But there are others.

In the first place, much of the Rubber in Ceylon is getting old. It is impossible to define the economic life of the Rubber tree as this depends greatly on the conditions under which it is grown and the treatment it has received, but there is no doubt that most of our older areas are now deteriorating. The rate of bark renewal is slow, and in many cases all that can be expected of manuring or other cultivation measures is the prevention of further deterioration and the maintenance of yields at their present level. An apt analogy can be drawn with old and out-of-date factory machinery which becomes increasingly difficult and expensive to keep in running repair. In these circumstances a fair case could be presented for replanting even were improved material not available.

Another important advantage of replanting is the opportunity which is afforded of regenerating poor soils, and of adopting modern opening methods. Although there is considerable scope for soil amelioration under old Rubber by the establishment of a cover of introduced or indigenous species, the process is more rapid in new clearings where erect leguminous green manures are easily grown. The question of soil treatment is further discussed below.

We have now shown that replanting with improved material is the only means by which yields may be raised to the high standard which will become the rule rather than the exception on up-to-date properties, and that the alternative is the gradual

deterioration of the older estates, or, at best, a small improvement in yields under regular cultivation. The difficulties and objections to replanting, agricultural and financial, must now be considered.

The argument is often adduced that it is folly to increase the yields of a material of which there is already an excess. This, however, is hardly the concern of the individual producer; his object must be the maintenance of his property in the most efficient condition possible. The inefficient producer must ultimately pay the penalty of those who, in any walk of life, cease to be competitors. The present area of budded Rubber in the world is estimated to be about 700,000 acres, and is rapidly increasing; to this Ceylon can only contribute some 4,000-5,000 acres, and it is therefore clear that Ceylon will be unable to maintain her position as a rubber-producing country unless replanting is undertaken on an extensive scale.

Almost more important, however, than competition between individual units in the Rubber industry is the question of competition with rival industries. The possibilities of new outlets being found for plantation rubber are mainly dependent on the product being available at a relatively low and stable price, and will obviously be increased when satisfactory profits can be made at such a price.

Apart from difficulties in financing replanting operations, the main reason that progress along these lines has hitherto been slow is the fear that budgrafts will not grow satisfactorily on our old soils. The chain of reasoning is admittedly not complete in that large areas of budgrafts have not yet been brought into tapping on replanted land in Ceylon, but all the available evidence points to the conclusion that the risk of such clearings remaining unproductive for an unreasonable length of time is very small *provided the importance of intensive cultivation is fully appreciated*. The writer has seen many replanted clearings good and bad, but has yet to see an entirely unsatisfactory clearing in which artificial and green manuring has been carried out on correct lines. It is his contention that the soil conditions in an average replanted clearing should be at least as good after four or five years as in a jungle clearing opened by old-fashioned methods with no proper protection against soil erosion. It may be difficult to develop a satisfactory stand on the very worst soils, though excellent growth has been seen on land which would be classed as far below average.

Estimates of the cost of bringing a replanted clearing into bearing vary considerably, and full figures up to maturity are not yet available. Experience derived from the more advanced clearings indicates that on average land in the wet low-country districts the young plants should reach tappable size in 7 to 8 years, the total cost being about Rs. 400·00 per acre. The cost will obviously vary according to local conditions, but estimates of Rs. 600·00, given in certain quarters, appear to be altogether too high except, perhaps, for the most sterile soils.

We are now in a position to consider the economic aspect of replanting in terms of comparative figures rather than broad generalisations. At present there is no deduction of coupons in Ceylon in respect of replanted areas, and therefore the only outlay is the expenditure on the actual work of replanting and maintenance up to the commencement of tapping. If, as seems likely, Restriction is continued for a further period of five years, areas replanted during 1936 could probably be brought into tapping before any loss of crop was felt.

On the debit side, therefore, we have Rs. 400·00 plus interest; say, a total of Rs. 450·00 per acre.

Let us consider the position of two estates in full production, with rubber selling at 20 cents per lb. (nett).

Estate A.—The old stand is giving 500 lbs. per acre, this yield being maintained by a moderate programme of cultivation.

Estate B.—This estate has been replanted and is yielding at the rate of 1,200 lbs. per acre, a moderate estimate of the potentialities of first-class clones on land capable of giving 500 lbs. per acre with unselected seedlings.

At present rates the skeleton costs of production might be approximately as under:—

	Estate A.	Estate B.
	Cents per lb.	
Overhead Charges ...	$5\frac{1}{2}$	$2\frac{1}{2}$
Tapping, Manufacture & Transport	$6\frac{1}{2}$	$3\frac{1}{2}$
Cultivation and Field Works	3	$1\frac{1}{2}$
Depreciation ...	2	1
	17	$8\frac{1}{2}$

At a nett selling price (*i.e.*, with Colombo charges, Directors' fees, etc. deducted) of 20 cents per lb., the nett profits would be as under:—

Estate A.	Rs.	15·00 per acre.
Estate B.	,,	138·00 ,,

With Rubber at a higher price the replanted estate would be at a still greater advantage. Below 17 cents per lb. Estate A would have to reduce salaries and eliminate cultivation to avoid loss, while at this price Estate B would still be making a profit of Rs. 102·00 per acre and would thus be able to maintain the capital value of the property.

It has admittedly been necessary to make a number of assumptions in arriving at the above figures, but it is clear that provided rubber remains saleable it will not be many years before the outlay on replanting is recovered. Even if it is necessary to raise fresh capital the project appears to be a very sound business proposition.

It is not altogether unreasonable to argue that Ceylon, with its handicaps of steep land, small units and relatively expensive labour, does not offer as attractive a field for investment as other rubber-producing countries, and that reserve funds could be more profitably utilised by buying shares in up-to-date companies elsewhere. While this policy might commend itself in certain individual cases the efflux of capital would have disastrous repercussions on the Island as a whole, the prosperity of whose entire population is so closely linked with that of the Rubber plantation industry. It is to the interest of those who have a permanent stake in the country, and particularly those whose livelihood is largely dependent on Rubber, to ensure that the industry is maintained at as high a standard of efficiency in Ceylon as in other countries.

COIR AS A CONSTITUENT OF RUBBER FLOORING MATERIALS.

M. W. PHILPOTT,
CHEMIST

PART of the policy and work of the Research Scheme during the past year has been to consider the possibility of manufacturing certain classes of rubber goods in Ceylon. A discussion of the general aspects of this subject may be found in an article that appeared in the Research Scheme *Quarterly Circular* for November, 1934. In this article an attempt was made to show that there is no *prima facie* case against the establishment of a rubber industry in Ceylon, but that intending manufacturers would be well advised to consider what classes of work could be undertaken with the greatest prospect of ultimate success. It was pointed out that all the usual constituents of manufactured rubber articles other than rubber itself would have to be imported from abroad but that a careful search might reveal a number of materials of local origin that could be utilised as rubber fillers.

The present report deals with an investigation on the preparation of a type of rubber flooring in which the rubber is compounded with a local material that is both plentiful and easily available, namely, coir waste.

The utilisation of coir residues is a subject not without interest to the coconut industry itself. No way has yet been devised of disposing of these residues to advantage and vast quantities are being produced yearly. It seemed fair to assume therefore that the cost of the coir to anyone having a use for it would be confined to the cost of handling and grading. The problem was to show that satisfactory rubber articles could be produced with coir as a bulking ingredient.

Two methods of working were investigated: in the first trials the coir was compounded with latex, but this method was later abandoned in favour of dry rubber compounding. For record purposes however the latex work will be briefly described.

(1) LATEX METHODS

The dust obtained by sieving waste coir was sprayed with compounded latex, dried and sheeted on the mill. In order to obtain a smooth sheet it was necessary to submit the treated coir to a considerable amount of mechanical working and the finish of the product left much to be desired. There was some difficulty also in handling the treated coir on the experimental mixing rolls owing to its tendency to slip. Larger batches were then made on the smooth 26-inch lace mill running at even speed. From the point of view of slip this machine proved more suitable than the small mixing mill and coherent sheets were more easily obtained. Whether this was due to the smaller curvature of the rolls or to the fact that the larger rolls were of cast iron instead of steel is uncertain. It was found impossible to obtain a product of good appearance merely by passing the material through the nip of the mixing rolls or calender several times, but the sheet was improved by allowing it to break down by passing continuously round the front roll.

Attempts were also made to produce sheets from latex treated coir by consolidation under pressure. Pressing in a mould at 130° for 10 minutes in a steam-heated hand press resulted in a solid block which, however, was not very coherent. Small quantities were also pressed cold under a pressure of 12,000 lbs. per square inch in an oil press, but again the product was not sufficiently strong to be useful.

It was concluded that the use of latex as the raw material in these experiments introduced a number of difficulties and although these might not be insuperable it was considered that time would be more usefully spent in developing an alternative method of dealing with the problem. In the absence therefore of any very marked advantages in the use of latex it was decided to start from dry rubber.

(2) DRY RUBBER METHODS

One of the limitations of the latex method was that many useful mineral compounding ingredients could not be used because of their de-stabilising effect on the latex. Another disadvantage of the latex method was that premature coagulation had to be prevented by the inclusion of stabilisers which were usually undesirable in the finished product. Neither of these

difficulties arose in compounding dry rubber on the mixing mill, and promising results were almost immediately obtained by this method.

The incorporation of the fillers with the rubber calls for no special comment. The usual procedure of masticating the rubber and adding the fillers was followed. All the ingredients with the exception of sulphur were added together, the sulphur being reserved till the last as a precaution against pre-vulcanisation. Calendering was best done with the rolls at a temperature of about 60°C; higher temperatures were inclined to cause the mixing to stick to the rolls.

(3) FORM OF FINAL PRODUCT

Attention was then given to the question of the form in which the material might conveniently be produced. An important consideration in making this decision was to select a form in which the manufacturing costs would be as low as possible. The first mixings were made into continuous sheets calendered to a thickness of $\frac{1}{8}$-inch, vulcanisation being effected by storing in a warm room.

The sheet material produced in this way had a slightly roughened surface owing to the lack of pressure during vulcanisation. This might be remedied by curing in a press of the belting type or in a continuous vulcaniser, but the cost of these units would be very high and their provision would only be justified if a very large annual production were contemplated.

As a result of discussion with local firms interested in the marketing of rubber flooring it was decided to consider then the possibility of making coir-rubber compositions in the form of floor tiles. Although the manufacturing costs would be greater than those of self-vulcanised continuous sheet flooring, the superior appearance of the tiles, it was thought, would probably justify their higher cost of production.

(4) VULCANISATION.

The mixings intended for tillings were designed to vulcanise in the press in 15 minutes at 135°, the accelerator being a mixture of mercaptobenzothiazole and dipentamethylene thiuram disulphide. Satisfactory products were also obtained with more highly accelerated compounds than this.

The floorings made in continuous lengths were compounded with a view to vulcanisation by maturing in a warm air chamber. By a suitable choice of accelerators and activating ingredients, mixings were obtained which vulcanised in air at 35° in periods ranging from 1 to 10 days. By heating at 100° in air, vulcanisation periods as short as 30 minutes were found to be possible on an experimental scale, but it is doubtful whether such rapid vulcanisation would be controllable on a large scale. The main point of interest is that coir does not inhibit to any marked extent the action of powerful vulcanisation accelerators.

(5) COMPOSITION.

The influence of different mineral ingredients and different proportions of rubber and coir was studied by making up a large number of trial mixings. As a result of these trials it was concluded that the required physical properties could be obtained by mixing the components in the following proportions:—

	Continuous sheet	Tiles
Rubber ...	33⅓ per cent	25 per cent
Coir waste ...	50 ,,	37½ ,,
Mineral ingredients, vulcanising chemicals, etc.	16⅔ ,,	37½ ,,

(6) PREPARATION OF THE COIR.

The dried waste residues of the fibre mills consist of a mixture of loose and matted fibres, together with a dust that has the appearance of ground cork. It was found that the total waste material could be ground to yield a fairly suitable light filler, but that better results were obtained by sieving off and grading the dust. A series of trials made with several grades of dust showed that from the point of view of appearance a suitable grade of dust was obtainable by sieving through a 60-mesh screen. The residues from the coconut estate which supplied the material were found to contain about 25 per cent. of dust of this degree of fineness.

(7) COMPARISON OF COIR WITH WOODFLOUR

The fibrous vegetable filler most extensively used in linoleum and rubber floorings is woodflour; it was therefore thought desirable to make a comparison between coir dust and woodflour in mixings of similar composition.

By the courtesy of the Chief Mechanical Engineer of the Ceylon Government Railway a sample of fine wood dust was obtained similar in appearance to the "woodflour" of commerce. The main differences observed between this and coir dust were: (1) The wood dust was lighter in colour and finer than 80-mesh, which was the finest grade of coir dust used; (2) the woodflour compositions could be mixed and calendered at a higher temperature than the coir compositions with the result that smoother surfaces were obtained. Coir appeared to have a specific effect on rubber causing it to adhere to the rolls if the mixing or calendering temperature rose much above 55°-60°; (3) the woodflour composition vulcanised somewhat more slowly than the corresponding coir composition.

The behaviour of woodflour was chiefly interesting as a standard for comparison with coir. No uniform large supplies of woodflour exist in Ceylon, whereas coir residues are a waste material available in almost unlimited quantities.

(8) BLEACHING COIR.

The relatively dark colour of coir residues suggested that it might with advantage be given a bleaching treatment before use. It was found that chlorine and chlorine producing materials, such as bleaching powder and sodium hypochlorite were capable of bleaching coir to a pale straw colour. An estimate of the cost of treating coir in this way, however, showed that the cost of the bleaching agent alone would contribute about 6½ cents per pound of coir to the cost of bleaching. This would be prohibitive since the chief virtue of coir waste as a filler is its cheapness.

Sulphur dioxide was also found to have an effect on the colour of the coir. A 10 per cent. solution of sodium bisulphite had little or no bleaching action but when acidified with dilute sulphuric acid to liberate sulphurous acid, a lighter material of warm reddish colour was obtained. Although the bleaching action of bisulphite was much less pronounced than that of bleaching powder, the strength of bisulphite solution could be reduced to 0·5 per cent or less without affecting the colour of the bleached product. The cost of materials for bleaching with bisulphite would be about one cent per pound of coir, a figure that does not preclude the possibility of adopting the treatment commercially.

This work has been temporarily discontinued because it has been found that a useful range of colours is obtainable even with unbleached coir. It is satisfactory to know, however, that the usefulness of the material can be extended by suitable treatment with bleaching agents.

(9) COLOURING THE MATERIAL

A large number of organic dyes were tried and compared for permanency with mineral pigments, such as iron oxides, ochres and chrome greens. The vulcanised samples were exposed to weather and direct sunlight and were examined from time to time for fading. Although the test is admittedly a drastic one it was disappointing to find that most of the organic dyes compared unfavourably with the mineral pigments with regard to permanency. Several of the dyes however lost their colour very slowly under the conditions of the test and would probably be satisfactory in service.

(10) AGEING

Samples of the flooring composition were exposed to the weather for periods up to nine months. Considering the severity of the test many of the samples show remarkably little deterioration. Most of the early samples show surface cracks and are bleached on the exposed side, but some of the later ones that have been exposed for three months are free from cracks and in very good condition. It is difficult to say what the results of such a test mean in terms of the probable life of the material under normal conditions of service, but it is satisfactory to note that several pieces of commercial flooring made by reputable British and American manufacturers deteriorated badly after three or four weeks of the treatment. All the evidence at present available tends towards the conclusion that coir has no adverse effect on ageing.

(11) SURFACE FINISH

The question of surface treatment presented some difficulty at first as the floor tiles would not take a polish when freshly prepared on account of the "drag" of the surface. The ageing trials referred to above, however, showed that a short exposure to direct sunlight (6 hours) hardened the surface in such a way that a polish could be applied.

In order to devise a method of producing the same result by more controllable means, a number of different treatments were tried. Exposure to ultra-violet radiation produced a slight hardening if continued for 3 hours, but more promising results were obtained from the action of halogens. Immersion in chlorine water containing 0·1 per cent of chlorine for 7 minutes gave a hard surface free from "drag". Bromine was not effective at this concentration, but an aqueous solution of about 1 per cent. of bromine gave a good finish after 2 minutes' immersion. When surface hardened by one of these methods the tilings took a very high polish on application of a wax dressing.

(12) COSTS

The cost of manufacture of the flooring material described above was estimated on the basis of an annual production of 150,000 square yards. The figures arrived at are as follows:—

	$\frac{1}{8}$-inch continuous sheet	$\frac{1}{4}$-inch tiles
Materials	Rs. 1·60 per sq. yard	Rs. 2·35 per sq. yard
Manufacture	,, 0·55 ,, ,,	,, 1·10 ,, ,,
Total	,, 2·15 ,, ,,	,, 3·45 ,, ,,

In estimating these costs uncouponed rubber was taken at 20 cents per lb. and coir waste at a figure (Rs. 30/- per ton) that should cover transport and handling. Manufacturing costs have been based on a depreciation allowance on machinery and buildings of 20 per cent. and a price of 7 cents a unit for electrical power. These rates are unnecessarily high but they were selected in order that a conservative figure might be arrived at.

It may be objected that the volume of production on which the above costs are based is too high to be of interest to potential manufacturers in this country. An estimate has therefore been made of the cost of making floor tiles with a unit capable of producing 7,500 square yards a year. Taking the costs of materials, depreciation, wages etc at the above rates the figure obtained is Rs. 4-50 a square yard.

(13) FUTURE DEVELOPMENT

These experiments have now reached a stage at which it is impossible to make further progress with the small-scale machinery at present available. Whether the results so far obtained are sufficiently promising to justify developments on a larger scale is a matter to be considered in relation to the general question of the desirability of establishing a manufacturing industry in Ceylon.

LATEX SHIPMENT.

M. W. PHILPOTT,

CHEMIST.

OF the advances that have been made in the technology of Rubber during the last decade, perhaps the most important is the development of methods of using rubber in the form of liquid latex. Progress in this direction is a result of activity at both ends of the industry; the consumer has contributed by making an extensive study of the properties and applications of latex and the producer by improving methods of transportation.

This is not the place to discuss the manifold uses of latex in industry. It is sufficient to say that many types of rubber goods that were formerly made from dry rubber by well-established methods are now made more satisfactorily and more cheaply direct from latex. It should, however, be emphasized that the quantity of latex that has replaced dry rubber is small compared with the amount that is used for entirely new purposes. Many of the applications of latex lie outside the scope of the rubber industry proper and it may safely be said that nearly all the latex shipped to manufacturing countries represents additional consumption and does not involve a corresponding decrease in the use of dry rubber.

The fact that between 1931 and 1934 the export of rubber in the form of latex from Malaya and the Dutch East Indies increased from less than 6,000 tons to 20,000 tons is a sufficient indication of the growing importance of latex as a raw material.

Isolated shipments of preserved latex from Ceylon have been made in the past, but the trade has never been developed seriously and few estates, if any, have been called upon to deal systematically with repeated demands for preserved latex of a definite quality.

At the present time there is a special reason for drawing the attention of the planting industry to an alternative method of preparing rubber for the market. Many estates are now replanting on a substantial scale with high-yielding material and will in a few years be faced with the necessity of installing new machinery to manufacture the increased crops that will be obtained when the young rubber comes into bearing. In such cases, it is suggested, the marketing of rubber in the form of preserved latex might be given specially close consideration. To manufacture into crepe or sheet an additional crop of say, 100,000 lbs. of rubber a year would involve a considerable capital outlay on machinery and factory accommodation, whereas equipment for dealing with this amount of rubber as normal preserved latex could be provided for a sum of less than a thousand rupees. Moreover, the factory space needed would be comparatively small.

There is evidence to show that while the uses of preserved latex are expanding, the demands of the market as regards quality and uniformity are becoming and will continue to become more exacting. It is suggested, therefore, that intending suppliers would be well advised to consider what are the consumer's requirements and how they may best be met.

This being the position, it is felt that many estate managers will wish to be in a position to accept contracts and to have available in a convenient form information on costs and methods. It is hoped that the following notes on the procedure recently adopted at Dartonfield for shipping a 500-gallon consignment may serve to provide this information.

Latex is usually shipped from the East either as normal preserved latex having a dry rubber content of 38 to 40 per cent. or as concentrated latex having a D.R.C. of 60 per cent. or more. Concentration may be effected by centrifuging, by creaming or by evaporation, but these notes will not deal with any problems other than those associated with the shipment of normal latex.

The preparation of latex for shipment is not difficult but a number of troubles may arise through the neglect of certain simple precautions. The first thing to be borne in mind is that spontaneous chemical changes occur in latex from the moment it issues from the tree. These changes proceed very rapidly until a stage is reached a few hours after tapping when the latex begins

to putrefy and to develop a degree of acidity that finally results in coagulation. It is clearly of importance that this acidity should be neutralised and further changes arrested with the least possible delay.

THE PRESERVATIVE

Any alkaline substance will have the desired effect of preventing spontaneous coagulation, but mention will be made here only of the most widely used preservative, namely, ammonia.

At ordinary temperatures and pressures ammonia is a gas that dissolves readily in water and gives a strongly alkaline solution. It is marketed commercially in two forms: as an aqueous solution and as a liquefied gas. It is necessary to consider the relative suitability of these two forms.

"Strong liquid ammonia" or *Liq. Ammon. Fortis* is a saturated solution of ammonia gas in water and is supplied in drums. Small quantities can also be purchased in bottles.

The concentration of ammonia gas in commercial liquid ammonia is normally about 35 per cent., but at tropical temperatures a saturated solution of ammonia in water will contain only 28 or 29 per cent. of the gas. Even at this strength the liquor loses ammonia rapidly if it is not kept in well-sealed drums. Liquid ammonia is most conveniently used in a less concentrated form such as is obtainable locally. This usually contains no more than 25 per cent. of gas.

The greatest care should be exercised in opening drums and bottles of ammonia as the sudden release of pressure on removing the stopper is liable to cause the liquid to blow from the container with considerable force. To minimise this danger drums should be kept in as cool a place as possible before they are opened and as a further precaution against accidents the operator should be provided with a mask to protect the eyes and face. If ammonia should reach the skin the affected parts should be well washed with water and then bathed with 1 per cent. acetic acid.

Apart from the inconvenience of handling strong ammonia it has the added disadvantage of diluting the latex with water. The amount of ammonia recommended for latex preservation is 0·7 per cent. so that 100 gallons of latex must be mixed with about 2½ to 3 gallons of liquid ammonia. This reduces the D.R.C. from, say, 39 per cent. to slightly under 38 per cent. and may therefore render it difficult or impossible to supply latex of a specified rubber content.

The other form in which ammonia is obtainable is as an anhydrous liquefied gas in iron cylinders of 61-lb. and 102-lb. capacity from which the gas is released at an easily controlled rate into the contents of the ammoniating tank. By this arrangement the ammoniation may be performed in such a way that the loss of gas to the atmosphere is scarcely noticeable by the operator. Moreover, no dilution of the latex takes place.

The chief point in favour of ammonia gas, however, is its relatively low cost. To ammoniate 100 gallons of latex we require:—

7 lbs. of ammonia gas at 75 cts. per lb.	Rs.	5·25
or $2\frac{1}{2}$ gallons of strong liquid ammonia at Rs. 6·50 per gallon ...	,,	16·25

This appears as a difference in production cost of over $2\frac{1}{2}$ cents per lb. of rubber.

EQUIPMENT FOR AMMONIATING AND BULKING

The equipment at Dartonfield (Fig. 1) is designed for use with gaseous ammonia and consists primarily of a mild steel ammoniating tank of 120 gallons capacity and a 600-gallon bulking and storage tank of the same material. These are painted internally with a chemically-resistant protective coating in order to minimise the risk of metallic contamination.*

The installation is capable of treating up to 100 gallons of latex a day and of bulking 500 gallons at a time. As it is seldom desirable to make shipments of smaller quantities than 500 gallons, bulking cannot be done on a smaller scale than this without sacrificing uniformity within the consignment. Obviously the larger the scale on which bulking is done the better, and at least one concern in Malaya has gone to the extent of bulking in 20,000-gallon tanks to secure uniformity.

The ammoniation is effected by passing ammonia gas from the cylinder through a length of $\frac{1}{2}$-inch gas piping to a gas distributor which rests in the bottom of the ammoniating tank. The distributor consists of four arms made from 1-inch gas piping perforated to allow the ammonia to pass evenly into the bulk

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* The Rubber Research Institute of Malaya have shown that many so-called chemically-resistant preparations are useless for this purpose but that a proprietary paint known as Tropelite Black shows promise and can be used with safety. If such a coating is applied to the inside of the tanks and frequently renewed there is no reason why ordinary iron or galvanised iron should not be used. If cement or tiled tanks are used for ammoniating no protective coat is required.

of latex. A screw-union allows the distributor to be detached for cleaning and a length of rubber hose forms a flexible connection between the pipe from the ammonia supply to the distributor. The gas cylinder is lashed to a weighing machine which is balanced before ammoniation begins. Gas is then bubbled into the latex until the weighing machine shows that the required amount of ammonia has been used.

After ammoniation the latex is run off into the bulking tank which is provided with a manhole fitted with a gastight cover.

The transference of latex from the bulking tank to the containers is effected by using compressed air to force the liquid through an outlet pipe that extends to the bottom of the tank. This pipe is connected to a length of rubber hose fitted with a cock which is closed as each container is filled and reopened when the next is placed in position.

THE CONTAINERS

Field latex is generally shipped in 40-gallon oil drums or in 4-gallon kerosene tins. The most popular packing in Europe appears to be wooden cases each containing two kerosene tins. The cases are made so that the tins fit tightly without any movement that might cause them to split.

The cost of new kerosene tins is 50 cents each without transport. They are normally coated with a trace of oil but this may be removed by washing with hot soapy water. It is a good practice before filling the tins to coat them inside with a film of rubber so that the latex is not subjected to metallic contact. This may be done by pouring a small quantity of ammoniated latex into the tin and swirling round rapidly until the whole of the interior is covered with a thin film. The excess is then poured off and the tins are drained and placed in the sun to dry. The tins are sealed by soldering the metal caps that are provided.

It is convenient, and it saves transport charges, to assemble the packing cases at the factory. The sizes of the planks required are:—

Sides	21 in. × 14 in.
Ends	14 in. × $9\frac{1}{2}$ in.
Top and bottom	21 in. × $10\frac{3}{4}$ in.

The cost of the cut planks is 45 cents per case and to this must be added about 4 cents for making the cases and binding them with hoop iron.

EQUIPMENT FOR AMMONIATING AND BULKING

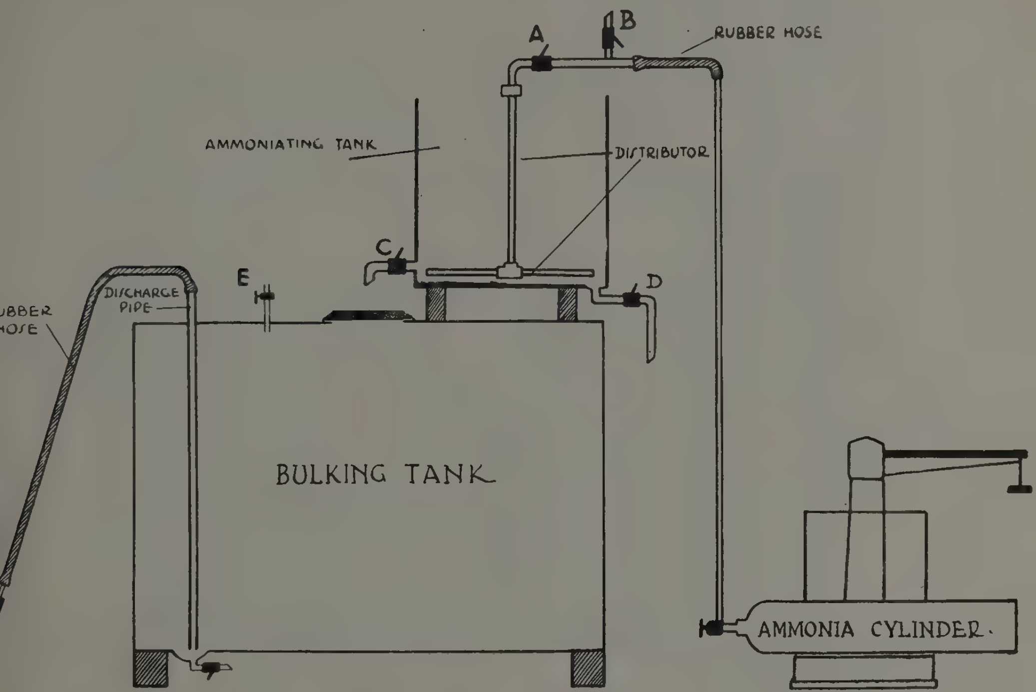

Fig. 1.

PROCEDURE

Assuming that the equipment has been installed and prepared for use, the recommended procedure is as follows:—

The latex is collected and brought to the factory in the ordinary way except that special regard must be paid to the question of contamination. Care and cleanliness in the collection of latex are even more essential to the production of preserved latex than to that of crepe or sheet. The presence of dirt and other foreign matter may accelerate the chemical and physical changes that it is our object to suppress and may have serious consequences in the subsequent history of the latex.

Latex should be collected for preservation only on fine days and it should arrive at the factory not later than 11-30 a.m. On days when tapping is begun late on account of early morning rain the crop should not be made into preserved latex. Similarly the latex collected by individual tappers who reach the factory late should be rejected.

Steps should be taken to secure the highest rubber content that conditions permit. Tappers should be warned not only to keep the latex clean but to refrain from adding water, and the sample taken at the factory and diluted for the D.R.C test should not be returned to the bucket.

On arrival at the factory the latex is strained, weighed up and tested with a hydrometer in the usual way. It should be borne in mind that hydrometer readings are only reliable if frequent checks are made against trial coagulations. The straining must be efficient and is preferably done through a steel mesh instead of the more usual brass. The latex is then poured through another strainer into the ammoniating tank with the distributor in position. When the first few gallons have been poured into the tank it is recommended that a small quantity of ammonia be added as a temporary anti-coagulant; the weight of the cylinder is noted on the weighing machine and ammonia gas is added at the rate of 1 lb. for every 100 gallons of the estimated crop. This is sufficient to neutralise any acidity that may have developed.*

When all the latex is in the tank the cylinder valve is opened gradually, allowing the gas to pass steadily into the latex. The amount of gas to be used is 7 lbs. per 100 gallons of latex, that is 0·7 per cent. This, together with the amount added as a temporary anti-coagulant, gives a total of 0·8 per cent but as there is an unavoidable loss in the transference of the ammoniated latex from one tank to another and in filling the containers, the final concentration of ammonia will probably not exceed 0·7 per cent.

The rate at which the ammonia gas should be added will depend on the volume of latex being treated. For a 100-gallon crop a rate of 1 to 1½ lb. in 5 minutes will be found convenient. The quantity of gas being used per minute may be observed by

* Actually, strong liquid ammonia was used for this preliminary dose. Ammonia gas, however, is preferable as regards both convenience and cost.

noting the rate at which the cylinder loses weight. When a little experience has been gained it is possible to judge the rate of ammoniation by the sound of the gas bubbling through the latex.

It will be noticed a few moments after opening the cylinder valve that the piping between the cylinder and the distributor becomes encrusted with frost. This is quite normal and is due to the absorption of heat by the expanding gas and the consequent deposition and freezing of atmospheric moisture.

When the calculated quantity of ammonia has passed into the latex the cylinder valve is closed and a valve A (Fig. 1) at the distributor is closed immediately to prevent latex from sucking back into the pipes. This leaves in the pipes a slight pressure of gas that must be discharged by opening valve B. The distributor unit may then be removed for cleaning by detaching it from the rubber hose. The tank is then covered and left overnight.

The following morning the cock C at the base of the tank is opened and the ammoniated latex is run off through a stainless steel mesh into the bulking tank. The greatest emphasis must be laid upon the use of suitable materials for straining latex after ammoniation. *Brass gauze must not be used.* Ammonia has a definite chemical action on brass and would be the means of introducing copper into the latex.

The outlet at C is about $\frac{1}{2}$-inch above the bottom of the tank. It will be found that a certain amount of grit and sludge settle out of the latex overnight and this must not pass into the bulking tank. It is, therefore, allowed to remain in the ammoniating tank and the following day's crop is added thereto. This procedure is followed daily and the accumulated sand and sludge is run off after about 7 days' ammoniation through the outlet D. This latex may be coagulated and made into low grade crepe.

Having collected 500 gallons in the bulking tank the latex is well stirred with a wooden paddle and a sample is taken for estimation of rubber and ammonia contents. In stirring, care must be taken that no rubbing takes place between the paddle and the sides of the tank as latex is sensitive to friction and rubbing may produce local coagulation.

Methods of estimating the rubber and ammonia contents of preserved latex are described in an appendix to this article. To carry out either of these estimations it is necessary to purchase

a certain amount of chemical apparatus. The methods of analysis are simple but estate managers who are asked to prepare trial consignments of latex will probably prefer not to provide testing equipment until they are assured of a regular demand. In such cases it is advisable to submit samples to the Research Scheme for examination.

If the D.R.C. of the latex is too high it is diluted with water at this stage to the required figure; similarly any deficiency in ammonia content is made good by the addition of strong liquid ammonia.

The standardised latex is now ready to be run into the containers. The bulking tank manhole is firmly clamped down to make the tank airtight and a slight pressure is introduced by connecting inlet E with a compressed air cylinder previously charged by means of a small compressor set. This pressure forces latex up the discharge pipe and into the flexible rubber hose connected to the discharge cock F.

If all the contents of the tank are not run into the containers on one day, the latex should be stirred before resuming operations in order to disperse any cream that may have formed overnight.

After filling the containers, the empty tank should be well washed out with water and then dried. If on inspection it is found that the paint on the inside of the tank needs renewing this should be done before the next batch of latex is preserved. This applies also to the ammoniating tank and to any other metal parts that come into contact with the latex.

If the latex is to be packed in kerosene tins it will probably be found convenient to fill them to within about an inch of the top and then to place them one by one on the weighing machine adding latex from a jug until the weight of the contents is exactly 40 lbs. The tins are uniform in weight so that it is not necessary to weigh each tin before filling.

When filling the containers the latex should be run in without the formation of froth. This is achieved by tilting the tin so that the latex runs down the side instead of splashing into the bottom. Kerosene tins have a capacity only slightly in excess of 4 gallons and any froth that is formed accidentally must be allowed to subside before the full 40 pounds can be introduced.

Pouring latex into ammoniating tank

Adding the ammonia

Filling and Sealing the containers

View of containers and cases

Weighing up the consignment before despatch

Fig. 2.

The caps are then soldered on the tins without delay. The chief point to bear in mind here is that the flux, which should be a paste rather than a liquid flux, must not come into contact with the latex. When cool, the tins are inverted to test for leaks and are then packed in pairs in wooden cases. Movement of the tins in the cases should be negligible if the cases are made to the correct size but if there is any play at all it should be checked by inserting wedges of paper or cardboard.

The foregoing remarks apply to the preservation of latex as it is carried out at Dartonfield. It is not suggested either that the equipment described is ideal or that other installations differing in detail would not be equally satisfactory.

COSTS

The following figures may serve to give an indication of the cost of preparing rubber in the form of ammoniated latex in comparison with that of manufacturing crepe.

Apart from general charges common to both forms of manufacture the chief expenses incurred in the preparation of 500 gallons of 40 per cent. latex (2,000 lbs. of rubber) are as follows:—

	R. c.
Chemicals.	
Ammonia gas, 40 lbs. @ 75 cts. ...	30·00
Packing and Transport.	
125 kerosene tins @ 50 cts. ...	62·50
Transport to estate @ 10 cts. ...	12·50
$62\frac{1}{2}$ wooden cases (loose) @ 45 cts. ...	28·15
Assembling cases ($4\frac{1}{2}$ coolies @ 50 cts.)	2·25
Stencilling and packing cases (5 coolies @ 41 cts.) ...	2·05
Transport (50 miles) ...	27·20
Shipping to London, @ Rs. 2·10 per case	131·25
Upkeep of equipment.	
1 coat protective paint, $\frac{1}{8}$ gal. @ Rs. 28	3·50
	299·40

i.e., 15 cts. per lb.

The corresponding figures for the manufacture of 2,000 lbs. of crepe are as follows:—

	R. c.
Chemicals.	
Sodium bisulphite, 8 lbs. ...	1·30
Formic acid, 5 lbs. ...	2·00
Packing and Transport.	
14 momi chests @ 96 cts. ...	13·45
Stencilling & packing cases (2 coolies)	90
Transport (50 miles) ...	10·00
Shipping to London, at $5\frac{1}{2}$ cts. per lb.	110·00
Power.	
50 h.p. engine for 14 hours @ 60 cts. per hour	8·40
	146·05

i.e., 7·3 cts. per lb.

It is assumed that labour costs are the same in each case. This is only approximately true but the difference, if any, is not sufficient to affect the trend of the figures given.

It would appear then that it costs about 8 cents a pound more to put rubber on the market as preserved latex in kerosene tins than as crepe in chests. In order that latex manufacture may be worth taking up this difference must appear as a premium of $1\frac{1}{4}d$ to $1\frac{1}{2}d$ per lb. over the buyer's price for crepe. In the case of latex in drums the premium could be somewhat less as this form of packing is cheaper than kerosene tins in cases. There is, however, little demand at present in the European market for latex in drums although America takes large quantities in this way.

MARKET

As was pointed out at the beginning of this paper, the demand for preserved latex is a growing one and although Ceylon has not entered the latex market, there would appear to be no prejudice among buyers against Ceylon latex if it were available. As evidence of this it may be mentioned that the London firm who purchased a trial shipment of latex from Dartonfield reported favourably on the consignment and expressed their willingness to accept shipments from other Ceylon estates working on lines approved by the Rubber Research Scheme.

APPENDIX I.

TESTING AMMONIA-PRESERVED LATEX

(1) DETERMINATION OF DRY RUBBER CONTENT

About 25 c.c. of a representative sample of the latex is poured into a conical shaped flask which is corked and weighed on a dispenser's balance capable of weighing to 0·01 gm. The latex is poured off into a flat glass or porcelain dish and the flask is re-corked and weighed again. The difference in these two weights is the weight of the latex in the dish.

The latex is coagulated by adding about 150 c.c. of ½ per cent. acetic acid and allowing to stand. The time taken for a coagulum to form varies considerably with the age and stability of the latex. When sufficiently firm, the coagulum is removed from the dish and transferred to another dish containing clean water. The serum should be quite clear but if there are loose pieces of coagulum floating in it they must be caught up with a glass rod and added to the main portion. The coagulum is consolidated by pressing out with a spatula or glass rod and is then sheeted out as thin as possible in a pair of hand rollers. The wet rubber is dried in a small oven at a temperature of about 120°F.

When dry, the rubber is cooled and carefully weighed, and the percentage rubber content calculated by dividing the figure so obtained by the original weight of latex and multiplying by 100.

(2) DETERMINATION OF AMMONIA CONTENT

10 c.c. of latex are taken in a pipette and run into a standard flask that holds exactly 200 c.c. when filled up to a mark on the neck. The latex is then diluted to this volume with distilled water and mixed thoroughly by shaking.

With another pipette, 20 c.c. of this diluted latex are then transferred to a beaker together with about 5 drops of methyl red solution. The latter confers a pale-yellow colour on the latex. Hydrochloric acid of the strength known as "decinormal" is then run into the latex from a burette, which is a long glass

tube graduated to show the volume of liquid used. The acid is run in until the yellow colour of the latex changes to a pale-pink. This is the point at which the ammonia present is just neutralised by the hydrochloric acid. A note is made of the volume of acid taken from the burette and the operation is repeated as a check with a further 20 c.c. of diluted latex.

The ammonia content is usually calculated as the number of parts by weight of ammonia per 100 parts by volume of latex. For practical purposes this is the same thing as the percentage by weight.

The calculation is performed as follows: 1 c.c. of decinormal acid is equivalent to 0·0017 grams of ammonia or 0·17 parts per 100 parts by volume of the original latex.

Thus, if the sample under test has a titration figure of 4·1 c.c. its ammonia content may be expressed as $4{\cdot}1 \times 0{\cdot}17$, *i.e.*, 0·70 per cent.

The keeping qualities of the acid solution are good but it is a wise precaution to submit a sample periodically to the Research Scheme Laboratories for standardisation.

APPENDIX II.

The consignment of latex, of which details are given in this paper, was examined on arrival in London in the Laboratories of the London Advisory Committee for Rubber Research (Ceylon and Malaya). The latex was reported on as follows:—

> "A shipment of latex prepared on the Ceylon Rubber Research Scheme Estate at Dartonfield consisting of 518 gallons of 38-40 per cent. latex, has been received in London and disposed of through the ordinary trade channels. This consignment is of interest since it is the first bulk latex to be prepared and shipped under the supervision of the officers of the Ceylon Rubber Research Scheme.
>
> "The latex was obtained over a period of eight days during which no rain fell. Gaseous ammonia was passed into the latex until it contained 7 lbs. per 100 gallons. The latex was allowed to stand overnight and then run off into a 600-gallon storage tank. The last few gallons containing some

sediment were left in the bottom of the ammoniating tank and the next day's crop added. This procedure was repeated each day. The ammoniating and bulking tanks were painted with tropelite black. The latex was packed in 4-gallon kerosene tins, the interiors of which were coated with a film of dried latex before filling.

"The broker handling the latex in London forwarded a 4-gallon tin to the London Advisory Committee Laboratories for the purpose of making an examination as regards quality. The latex was therefore examined by a number of tests which are now standardised in the London Advisory Committee Laboratories.

"*Colour.*—The colour was compared with that of a range of colour plates which have been prepared for classifying the colour of latex. This showed the latex to be of excellent colour. When creamed the lower serum layer was a pale-yellow colour, in contrast with the greyish-coloured serum usually obtained with preserved latex, indicating the almost complete absence of iron sulphide. The interior coating of the tin with dried latex appeared to be in good condition.

"*Dry rubber and ammonia content.*—The dry rubber content was 38·48 per cent. and the ammonia content was 0·71 per cent. The figures given by Mr. O'Brien were 38·57 per cent. and 0·73 per cent. respectively.

STABILITY

"(a) *Sieving.*—The whole of the latex (1,000 ccs.) passed through both the 40 and 90-mesh sieves. Only a small amount of solid matter was retained on the sieve, indicating an amount of solid matter below normal.

"(b) *Stirring.*—When mixed with 50 per cent. of zinc oxide 138,000 revolutions of the stirrer were necessary to cause coagulation. This is much higher than normal, and may be due to the larger amount of ammonia used for preservation.

"*Film Strength Test.*—The strength of the dried film before ageing was 1,670 lb./sq. in; after ageing for 16 hours at 95°C the strength was 780 lb./sq. in. These results are very satisfactory.

"*Summary*.—This sample of latex is generally of excellent quality, both as regards the colour of the latex and of the dry film, freedom from solid matter, stability and film strength. The addition of 0·7 per cent. of ammonia as against the usual 0·5 per cent. may have helped to ensure a satisfactory product.

"The treatment of the tins with latex and then drying prior to filling has given satisfactory results, though this has not been the general experience in Malaya."

FIRST INTERIM REPORT ON INVESTIGATIONS IN PROGRESS AT THE IMPERIAL INSTITUTE ON THE UTILISATION OF RUBBER LATEX FOR ROAD SURFACING*

STAFF

INVESTIGATIONS on the utilisation of latex for road surfacing were commenced on June 1, the Staff engaged for the purpose consisting of Messrs. W. G. Wren, B.Sc., and A. T. Faircloth. Mr. Wren was previously associated with Professor Clements in carrying out similar investigations on behalf of the Rubber-Growers' Association. Mr. Faircloth was previously employed as Senior Assistant at the Imperial Institute and had many years' experience in cement testing. He was only available for part-time service until August 31st, but from that date the whole of his time will be directed to the latex roadway investigation.

GENERAL SCHEME OF INVESTIGATION

The most promising of a number of methods available for applying latex to roadways is that developed by the Rubber Research Institute and consisting in the treatment of latex with aluminous cement. In the first instance attention was therefore devoted to this process, bearing in mind that other methods of removing water will eventually require examination. The first step consisted in carrying out experiments to obtain as much fundamental information as possible concerning the physics and chemistry of latex-cement mixtures with a view to gaining experience and knowledge of value in developing a suitable process.

The following are the directions in which progress has been made during the three months ending August 31st, viz:—

(1) Development of technique for the microscopic examination of latex-cement mixtures with a view to following the interaction between latex and cement under various conditions and to studying the structure of the dry material.

* This work is financed by a special grant from the Rubber Research Institute of Malaya.

(2) Determination of the extent to which latex is chemically dehydrated by aluminous cement.

(3) Study of the effect of a wide range of protective colloids on the setting and mechanical properties of aluminous cement.

(4) Study of effect of compounding ingredients and coagulants on the physical properties of unvulcanised latex films.

These investigations are still in the preliminary stage, except that dealing with the effect of protective colloids on the hardening and mechanical properties of cement. This investigation has shown that under certain conditions some protective colloids almost entirely prevent the setting and hardening of cement to a coherent mass and that others accelerate it. This information is of considerable practical importance, particularly if at a subsequent stage it is found desirable to prevent the adhesion of cement particles to each other with a view to retaining an elastic structure.

In the course of investigations on the effect of compounding ingredients and coagulants on the properties of dried latex films a means was found for preparing raw rubber crumb in a very fine condition. It was found possible also to prepare latex-cement mixtures in the form of a crumb which could be pressed under a load of approximately 1,000 lbs./sq. in. to give coherent slabs which appeared to be stronger and more elastic than those prepared by allowing the latex-cement mixtures to dry *in situ*. The preparation of latex-cement mixtures in crumb form has advantages as regards ease of laying and reduction of tendency to crack and the properties of this form of mixture will be studied more fully as opportunity occurs.

More detailed particulars of the progress made during the three months ending August 31st are given below:—

(1) MICROSCOPIC TECHNIQUE

Attempts were made to prepare sections for examination by transmitted and reflected light. It was found that grinding at atmospheric temperatures removed particles of cement from the rubber but smooth surfaces suitable for examination by reflected light could be obtained by grinding with No. 600 carborundum in liquid air. It was not found possible to cut or grind

thin sections suitable for examination by transmitted light even when frozen in liquid air or in solid carbon dioxide. Attempts to prepare sections for examination by reflected light by casting on to glass plates were not successful owing to the formation of a film of rubber at the surface of the glass plate.

A few preliminary experiments were made with osmic acid, sudan III and iodine as staining agents for rubber and with alizarine for cement. Of these, osmic acid was the least promising and it is proposed to give the remaining staining agents a more extensive trial and also to experiment with others. It was observed that a solution of alizarine did not stain a mixture of cement in rubber prepared on the mixing rolls although it stained one prepared from latex.

The problems involved in the microscopic examination of latex-cement mixtures have been discussed with Professor Tabor of the Botanical Department of the Imperial College and a suitable microscope and photographic apparatus approved by him are being purchased to replace those borrowed from the Imperial Institute and the Imperial College for the preliminary investigations.

(2) CHEMICAL DEHYDRATION OF LATEX BY CEMENT

There is considerable doubt as to whether cement combines with the whole of the water in latex, and particularly that which is associated with the caoutchouc as water of hydration, and it may be difficult to remove this uncombined water by surface evaporation from carpets of about 1 inch thickness. Rubber which is associated with water is much weaker and less elastic than dry rubber, and is more likely to develop defects at low temperatures. A preliminary experiment has shown that there is an appreciable rise in temperature (of about 4°C) when latex is mixed with cement. This is evidence that the cement combines with a portion of the water in latex, which of course. is not unexpected. More comprehensive experiments have been designed, however, to determine the amount of free and combined water in latex-cement mixings. These will take some time to complete. The problem is a difficult one owing to the fact that under such conditions the cement contains water which is in equilibrium with the moisture in the atmosphere and it may not be possible by chemical methods to determine the amount of water retained by the rubber.

(3) EFFECT OF LATEX STABILISERS ON THE PROPERTIES OF CEMENT

When ammonia-preserved latex is mixed with aluminous cement, it quickly coagulates unless it is previously treated with a stabiliser. A wide range of materials may be used for this purpose and owing to their surface effects may have an important influence on the setting and hardening and other properties of cement. A wide range of protective colloids dissolved in water was therefore mixed with fixed proportions of aluminous cement and their effect is shown in Tables II and III. The stabilisers can be divided into three classes, (Table I) viz. (1) those which do not retard hardening and in some cases improve the tensile strength of cement. (An example of this type of stabiliser is gum arabic); (2) those which retard hardening and reduce the tensile strength of cement. (An example of this type is saponin); (3) those which have a marked plasticising effect on the cement, so that in the presence of fixed proportions of water the aqueous cement is much more fluid in the presence of the stabiliser. (An example of this type of stabiliser is saprotin).

It is evident that in future experiments with latex and cement the different effects of the three types of stabilisers will require consideration. For example it is possible that saponin will yield a more "rubbery" type of material than gum acacia as it may prevent the cement particles from building up in the form of a continuous cement structure, and saprotin may have advantages as regards ease of handling.

(4) EFFECT OF COMPOUNDING INGREDIENTS AND COAGULANTS ON THE PHYSICAL PROPERTIES OF UNVULCANISED LATEX FILMS

Previous work has shown that the tensile strength of rubber and cement mixtures prepared from latex and cement is less than the tensile strength of either the cement or the dried latex alone. It was, therefore, considered to be of importance to determine the effect of materials other than cement which may subsequently be of value in connection with the work. The preparation of films suitable for testing was, however, found to present certain difficulties, chiefly due to the presence of air bubbles, uneven surface, and the settling out of the fillers. Another difficulty which has previously been found to affect the results was the presence of small amounts of residual moisture in the dried film.

A few results have been obtained on the effects of adding carbon black, benzene emulsion and silica gel to latex. The latter, obtained from water glass by precipitation with acid *in situ* appears to improve the tensile strength. This is of interest in connection with other problems which have been encountered in these laboratories.

SUMMARY

(1). Methods of preparing sections for microscopical examination have been developed in order to obtain information as to the structure of latex-cement mixtures.

(2). A large range of protective colloids which act as stabilisers of rubber latex have been examined as to their effect on the physical properties of aluminous cement, particularly on the rate of setting and hardening and tensile strength. Important differences in the effects produced by these substances have been found.

(3). The possibilities of preparing a rubber cement crumb for consolidation on the highway are under examination.

(4). A few experiments on the effects of compounding ingredients on the tensile strength of dried latex (without mastication) have been made. Silica gel improves the tensile strength of the dried film.

TABLE I.

Classification of stabilisers according to their effect on aluminous cement.

Those which do not retard hardening and in some instances accelerate both the setting and hardening and improve the tensile strength	Those which markedly retard hardening	Those which show a marked slumping effect in 1 per cent. solution	Those which have no slumping effect in 5 per cent. solution	Those which markedly reduce the tensile strength of sand-cement mixtures, especially using 5 per cent. solution
Gum acacia	Saponin	Dextrine	Casein	Saponin
Gum acacia in ammonia	Saponin in ammonia	Gelatin	Starch	Saponin in ammonia
Potash soap	Peptone	Sodium* silicate (crystals)	Agar-agar	Starch
Ammonium stearate	Water glass	Saprotin	Potash soap	Sulphonated lorol
Potassium hydroxide	Saprotin	Darvan powder	Ammonium stearate	Nekal
Bentonite	Darvan powder	Dispersol	Potassium hydroxide	Potash soap
	Gelatin		Bentonite	Sodium silicate (crystals)
				Potassium hydroxide

* Slumping effect only slight with 5 per cent solution,

TABLE II.

Summary of 28-day tensile strengths of mixtures composed of 3 parts of British standard cement-testing sand to 1 part of cement fondu by weight gauged with 1 per cent. and 5 per cent. solutions, respectively, of various stabilisers, etc.

	AIR		WATER	
	1 per cent	5 per cent	1 per cent	5 per cent
Control, sand, cement and water only	488		435	
Do gauged with 1, per cent NH_4OH	527		407	
1. Casein	395	380	395	440
2. Saponin		Too weak	to test	
2A. Saponin + ammonia (3 per cent)	177	—	—	—
3. Certus Glue	477	417	405	420
4. Sulphonated lorol	473	148	410	143
5. Nekal	407	237	397	170
6. Introsol	463	483	423	457
7. Starch solution	283	203	370	287
8. Peptone	527		467	340
9. Lecithin		Not	tested	
10. Gum acacia	470	558	452	483
10A. Gum acacia + ammonia	473	500	412	468
11. Dextrin	212	473	320	443
12. Agar-agar	523	227	417	330
13. Egg albumen	587	550	423	453
14. Gum tragacanth	248	—	387	—
15. Gelatin	490	430	392	400
16. Potash soap	497	268	420	275
17. Ammonium stearate	553	445	407	442
18. Sodium silicate (crystallised.)	538	283	383	215
19. Water glass (1·7 sp.gr.)	490	375	372	360
20. Saprotin	350	—	338	387
21. Darvan powder	510	350	403	363
22. Potassium hydroxide	422	232	312	293
23. Bentonite	537	340	398	360
24. Dispersol	527	418	405	383

MEETINGS, ETC.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the twenty-ninth meeting of the Board of Management held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, at 10 a.m. on Thursday, 7th November, 1935.

Present.—Dr. J. C. Hutson (in the chair), Mr. C. H. Collins, C.C.S., (Deputy Financial Secretary), Messrs. C. E. A. Dias, J.P., L. B. de Mel, J.P., U.P.M., George E. de Silva, M.S.C., L. P. Gapp, F. H. Griffith, Col. T. G. Jayewardene, V.D., M.S.C., Messrs. J. L. Kotalawala, M.S.C., R. N. Rolfe, E. C. Villiers, M.S.C., E. W. Whitelaw and Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director of Research, was also present by invitation.

Apology for absence was received from Mr. C. A. Pereira.

MINUTES

Minutes of the last meeting which had been circulated to members were signed and confirmed.

BOARD

The Chairman welcomed Mr. F. H. Griffith and Col. T. Y. Wright who had resumed their seats on return to the Island as from October 1st and 23rd, respectively, and thanked Mr. G. E. Venning and Mr. R. A. Sharrocks who had acted for them.

OIDIUM CONTROL

Referring to the decision reached at the last meeting to apply for a grant of Rs. 20,000/- from the Restriction Fund to carry out a scheme of sulphur dusting in the Central Division during the 1936 refoliation season on a contributory basis, the Chairman reported that enquiries made by the Divisional Agricultural Officer showed that small-holders were not prepared to make any contribution to the cost of treatment and only a few proprietors of small estates had agreed to do so.

After discussion, it was decided to proceed with the scheme (subject to funds being allotted) without charging for the treatment, in order to demonstrate the value of sulphur dusting and to gain experience of the type of organisation required for large-scale dusting operations. It was noted that the scheme could only be carried out if funds are allocated before November 30th.

ACCOUNTS

(a) *Estimates of Income and Expenditure for 1936.*—Draft estimates, which had been circulated to members, were considered in detail. After discussion, the following estimates were adopted:—

Income		Rs. 170,600·00
Expenditure recurrent	Rs. 139,695·00	
Expenditure non-recurrent:		
Buildings ...	,, 57,885·00	
Equipment ...	,, 8,000·00	
Agricultural Development	,, 8,269·00	
Extension of cart-road	,, 4,000·00	Rs. 217,849·00

Non-recurrent expenditure includes provision for extension of the main laboratory block and construction of one senior staff bungalow, head clerk's bungalow and three junior staff bungalows at Dartonfield, with a view to completing the transfer of headquarters to the estate in 1937.

Provision is also made for replanting 10 acres on experimental lines and completing an inspection road through the estate.

(b) *Statement of Receipts and Payments of the Board for the Quarter ended 30th September, 1935*—was adopted.

(c) *Dartonfield and Nivitigalakele Accounts*—for August and September, 1935, were tabled.

PUBLICATIONS

(a) Combined *1st and 2nd Quarterly Circular* for 1935 and Leaflet No. 14 (revised edition) "The Sulphur Dusting Treatment for Oidium" were tabled.

(b) It was decided to accept contributions to *The Quarterly Circular* from persons other than Research Scheme Officers, at the discretion of the Director and subject to the proviso that the Board does not take responsibility for the views expressed in such articles.

(c) It was decided to accept advertisements for inclusion in *The Quarterly Circular*, at the discretion of the Director.

STAFF

The service agreement signed by Mr. C. A. de Silva, Assistant Botanist, was tabled and the Chairman and Mr. C. H. Collins were asked to authenticate the Board's Seal on the document.

FIELD EXPERIMENTS AT DARTONFIELD

Detailed proposals for a tapping and a manuring experiment in mature rubber, which had been drawn up by the technical staff and approved by the Experimental Committee were considered and approved.

Details of the replanting experiment to be carried out in 1936, comparing three methods of opening the land, three methods of planting and the efficiency of organic and inorganic fertilisers, were discussed and approved, subject to the dissent of one member, who considered that the layout of the experiment was unsatisfactory.

RUBBER FLOORING COMPOSITIONS

Specimens of rubber flooring tiles compounded with coir residues were exhibited by Mr. Philpott who explained the method and probable cost of manufacture. The possibility of preparing the material on a semi-commercial scale to demonstrate the practicability of the process was considered and it was decided to discuss the matter in detail at a meeting to be held in December.

The meeting closed with a vote of thanks to the Chamber of Commerce for the use of the Committee Room.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirtieth meeting of the Board of Management, held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, at 10 a.m. on Thursday, 12th December, 1935.

Present.—Dr. J. C. Hutson (in the chair), Mr. C. H. Collins, C.C.S., (Deputy Financial Secretary), Messrs. I. L. Cameron, C. E. A. Dias, J.P., L. B. de Mel, J.P., U.P.M., George E. de Silva, F. H. Griffith, Col. T. G. Jayewardene, V.D., Messrs. J. L. Kotalawala, C. A. Pereira, E. W. Whitelaw and Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director of Research, was also present by invitation.

Mr. M. W. Philpott, Chemist, was present until conclusion of the discussion on rubber flooring compositions was completed.

Apologies for absence were received from Messrs. R. Neville Rolfe, E. C. Villiers and L. P. Gapp.

MINUTES

Draft minutes of the twenty-ninth meeting, which had been circulated to members, were confirmed and signed by the Chairman.

BOARD

The Chairman reported that Mr. E. W. Whitelaw had been renominated by the Rubber-Growers' Association as one of its representatives on the Board for a further term of three years from 14-12-35.

SULPHUR DUSTING SCHEME

The Chairman reported that a grant of Rs. 20,000/- from the Rubber Restriction Fund had been allotted for the purpose of carrying out the scheme of sulphur dusting in the Central Agricultural Division. Arrangements for the work were being made by Mr. W. I. Pieris with the co-operation of the Department of Agriculture. It was decided to issue an advertisement, stating that preference in the selection of areas for dusting, would be given to proprietors who were prepared to contribute towards the cost of the work on the following basis:—

Small estates (10-100 acres)	...	Rs. 2·50 per acre
Small-holdings (less than 10 acres)	...	Rs. 1·00 ,, ,,

RUBBER FLOORING COMPOSITIONS

Specimens of tiles and flooring material in sheet form, made from rubber and coir waste mixtures on the experimental machinery at Dartonfield, were inspected. Proposals were considered for the installation of larger machinery for trials of the process on a semi-commercial scale. It was decided to obtain a report on the proposals from the Government Electrical Department before taking further steps.

STAFF

Mr. T. E. H. O'Brien's Agreement.—Terms of re-engagement were decided on.

Mr. W. I. Pieris' Agreement.—Terms of the agreement were approved and the Chairman and Mr. C. H. Collins were asked to authenticate the Board's Seal on the document.

Junior Staff.—Changes in Clerical Staff were reported.

Travelling Allowances.—It was decided to pay mileage allowances on a flat rate basis instead of following Government scales of payment, with effect from January 1, 1935.

Rent Allowances—Junior Staff.—It was decided to pay rent allowances to officers for whom quarters are not provided, on the following scales, with effect from January 1, 1935:—

Married Officers	...	10 per cent. of salary,
Unmarried ,,	...	7½ ,, ,, ,, ,,

APPOINTMENT OF SOIL CHEMIST

A proposal for the appointment of a Soil Chemist was considered in relation to the financial position of the Scheme. Several members stressed the importance of work on soil problems being undertaken without delay and it was decided to make an appointment as soon as the financial position permits.

TRANSFER OF HEADQUARTERS TO DARTONFIELD ESTATE

In view of the arrangement to transfer the Headquarters of the Scheme to Dartonfield towards the end of 1936 it was decided to give 12 months' formal notice to terminate the lease of buildings at Culloden Estate.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirty-first meeting of the Board of Management, held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, at 2-30 p.m. on Thursday, 19th March, 1936.

Present.—Mr. C. H. Collins, C.C.S. (Deputy Financial Secretary), Mr. I. L. Cameron, Mr. C. E. A. Dias, J.P., Mr. L. B. de Mel, J.P., U.P.M., Col. T. G. Jayewardene, V.D., Mr. J. C. Kelly, Mr. F. A. Obeyesekere and Mr. C. A. Pereira.

Mr. R. K. S. Murray, Acting Director of Research, was also present by invitation.

In the absence of the Chairman, Mr. C. H. Collins was voted to the chair.

Apologies for absence were received from the Hon. Mr. J. L. Kotalawala, Messrs. B. M. Selwyn, E. W. Whitelaw, and Col. T. Y. Wright.

MINUTES

Draft minutes of the thirtieth meeting, which had been circulated to members, were confirmed and signed by the Chairman.

BOARD

The Chairman reported the following changes in membership of the Board since the last meeting:—

(a) Resignation of Mr. L. P. Gapp and nomination of Mr. J. C. Kelly of Messrs. Mackwoods Ltd in his place with effect from 27-2-36.

(b) Re-nomination of Col. T. Y. Wright to serve on the Board as one of the representatives of the Ceylon Estates Proprietary Association for a further period of three years from 21-4-36.

(c) Resumption of membership by Mr. B. M. Selwyn on his return to the Island, relieving Mr. R. Neville Rolfe, who was acting for him.

A vote of appreciation of Mr. Gapp's services to the Board was passed. Mr. Kelly was welcomed to the Board, and Mr. Rolf was thanked for his acting services.

DECISIONS BY CIRCULATION OF PAPERS

(a) *Memorandum* re *Soil Erosion.*—Reported that the memorandum had been approved and sent in reply to the enquiry from the Central Board of Agriculture.

(b) *Travelling Expenses of the Director of Research in England.*—Reported that members had agreed to payment of travelling expenses to Mr. O'Brien for visits to factories, institutions etc. as approved by the Chairman of the London Advisory Committee up to a total amount not exceeding £50.

(c) *Mr. R. K.S. Murray Acting on Budded Rubber Assessment Board.*—Reported that members had agreed to Mr. Murray's serving on the Budded Rubber Assessment Board during the period of Mr. O'Brien's absence on leave.

RUBBER FLOORING COMPOSITIONS

A favourable report had been received from the Government Electrical Department regarding the power supply available at Dartonfield, and it was decided to apply to the Department of Industries for a grant of Rs. 30,000/- to cover the cost of purchasing and installing machinery for manufacturing rubber flooring and other products on a semi-commercial scale.

LONDON ADVISORY COMMITTEE

Consideration of the question of continuing to contribute towards the expenses of the London Advisory Committee was deferred, pending the establishment of the proposed International Research Institute.

APPOINTMENT OF A SOIL CHEMIST

It was decided that a Soil Chemist should be appointed as soon as funds were available. In order to enable prospective candidates to qualify for the post, it was decided to make it publicly known that a Soil Chemist would probably be appointed in 1937 or 1938.

ACCOUNTS

(a) Statements of Receipts and Payments of the Board for the 4th quarter 1935 and of the London Advisory Committee for the 3rd and 4th quarters 1935 were adopted.

(b) Balance Sheet and Income and Expenditure Account and Auditors' Report for 1935 were adopted and supplementary votes passed to cover excesses of expenditure on 1935 estimates.

(c) Unexpended balances of capital votes passed in 1935, totalling Rs. 54,761/- were re-voted.

(d) A list of unserviceable articles written off the inventory in 1935 was tabled.

(e) Dartonfield and Nivitigalakele Accounts for October, November and December, 1935, were tabled.

(f) Furniture lists of senior, junior and superintendent's bungalows were tabled.

(g) Payment of a gratuity of Rs. 20/- to the rubbermaker of Kandanuwara Estate, Matale, for supervision of latex measurements in connection with Oidium experiments in 1935 was sanctioned.

(h) Reported renewal of fixed deposits totalling Rs. 105,000/- and transfer to current account of deposits totalling Rs. 40,000/- to meet anticipated expenditure on buildings.

Annual Report for 1935 was adopted.

STAFF

(a) *Mr. W. I. Pieris' New Agreement.*—Reported that this had been signed and the Board's Seal on it authenticated by the Acting Chairman and Mr. Collins.

(b) *Mr. T. E. H. O'Brien's Agreement.*—Leave terms decided on at the last meeting were confirmed.

(c) *Junior Staff.*—Changes in laboratory and estate staff were reported.

Sick leave taken in excess of the prescribed period by two officers was allowed.

EXPERIMENTAL COMMITTEE

(*a*). Mr. E. W. Whitelaw's resignation was noted with regret and Mr. C. E. A. Dias was appointed to fill the vacancy.

(*b*). Col. T. G. Jayewardene, who had vacated his seat by reason of absence from three consecutive meetings of the Committee, was reinstated.

(*c*). Mr. I. L. Cameron gave notice of his resignation from the Committee owing to pressure of other work.

(*d*). The Committee's recommendation that the publications of the Scheme should be sent to the Algemeen Landbouw Syndicaat was approved.

(*e*). The Committee's recommendation regarding revision of technical handbooks was approved, but it was agreed that action would have to be deferred until Mr. O'Brien's return from leave.

It was decided to obtain a number of copies of the Malayan Rubber Research Institute's Planting Manual No. 5 entitled "The History and Description of Clones of *Hevea Braziliensis*" for sale locally in view of the prevailing interest in replanting.

(*f*). The Committee's recommendation that technical officers' progress reports should in future be issued at quarterly instead of monthly intervals was approved.

(*g*). The Committee's recommendation that a charge should be made for electric current supplied to officers' bungalows and that they should not be allowed to instal appliances which consume a large quantity of power was approved.

(*h*). *Visitors' Days at Dartonfield.*—The following recommendations of the Committee were approved:—

That there should be fixed visitors' days and that the Estate Superindent should be available each Wednesday and the Technical Officers on the *second* and *fourth* Wednesdays of each month in order to show visitors round the estate.

That intending visitors should be asked to arrive by 9-30 a.m.

That explanatory notice boards should be provided in each experimental area.

(*i*). *Approach Road to Dartonfield.*—It was decided to apply to Government for a grant for maintenance of the road.

(*j*). *1936 Replanting Experiment.*—It was decided that an experiment for measuring erosion from the contour drained areas by installing cement tanks to collect silt should be undertaken as soon as possible.

SMALL-HOLDINGS' WORK

A Sub-Committee consisting of the two representatives of small-holders on the Board, the Director of Research and the Small-holdings Officer was appointed to consider the organisation of small-holdings work. In order to obviate delay in the work of the Small-holdings Officer, the Committee was authorised to appoint one instructor before its report is considered by the Board.

The meeting closed with a vote of thanks to the Chair.

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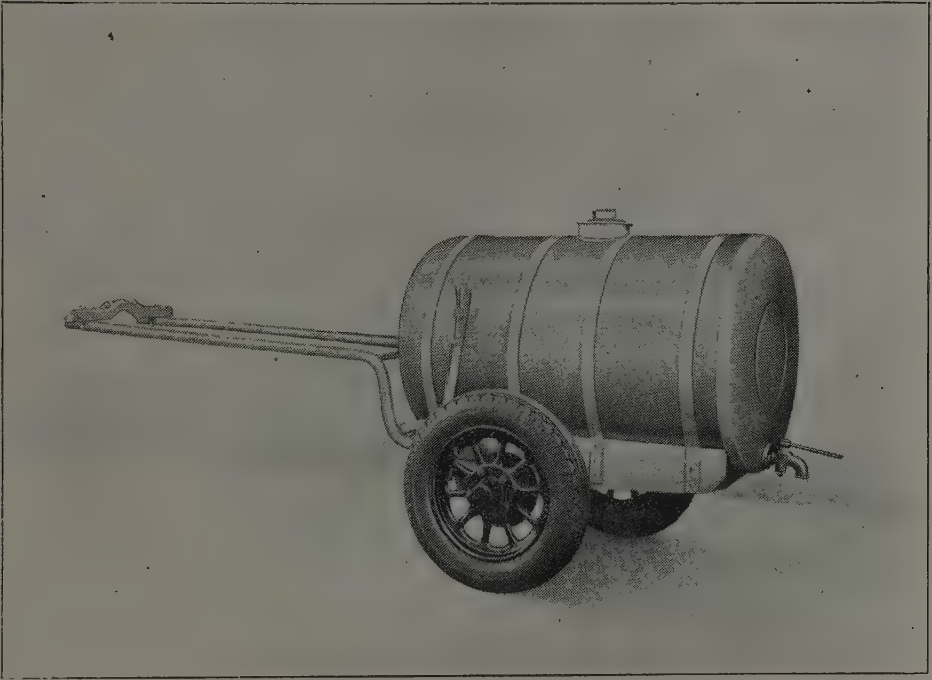

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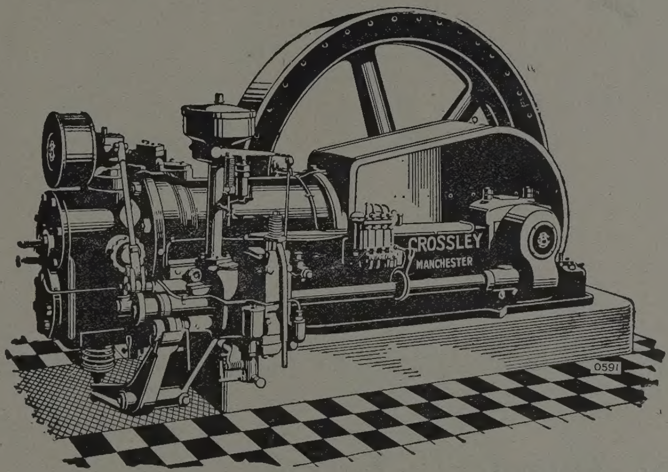
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London Advisory Committee for Rubber Research (Ceylon and Malaya).

Member nominated by the Colonial Advisory Council of Agriculture and Animal Health.

Mr. F. A. Stockdale, C.M.G., C.B.E.

Member nominated by the Government of Ceylon.

Lieutenant-Colonel Sir David Prain, C.M.G., C.I.E.

Member nominated by the Governments in British Malaya.

Mr. J. Lornie, C.M.G.

Members representing Malayan Planting interests — nominated by the Rubber Growers' Association.

Mr. P. J. Burgess, (Chairman),
Mr. W. J. Gallagher,
Mr. H. Eric Miller.

Members representing Ceylon Planting interests — nominated by the Rubber Growers' Association.

Sir Herbert Wright,
Mr. G. H. Masefield,
Mr. George Brown.

Member representing Manufacturing interests.

Lieutenant-Colonel J. Sealy Clarke.

Ex-Officio Members.

Sir H. A. F. Lindsay, K.C.I.E., C.B.E., Director of the Imperial Institute.
Professor V. H. Blackman, Director of the Botanical Laboratories, Imperial College of Science and Technology.
Mr. S. F. Ashby, Director of the Imperial Mycological Institute.
Sir John Russell, O.B.E., Director of the Rothamsted Experimental Station.

Secretary.

Mr. J. A. Nelson, B.Sc.

The Technical Sub-Committee consists of members of the Advisory Committee with the following co-opted Members.

Mr. G. Martin, (Superintendent of Rubber Investigations).
Mr. G. E. Coombs,
Mr. Ian. D. Patterson,
Mr. B. D. Porritt,
Mr. H. N. Ridley,
Mr. W. C. Smith,
Dr. H. P. Stevens,
Dr. D. F. Twiss.

STAFF.

Mr. G. Martin, B.Sc., A.I.C., F.I.R.I.,
Mr. W. S. Davey, B.Sc., A.I.C., F.I.R.I.,
Mr. H. C. Baker, M.Sc., A.I.C., A.I.R.I.

RUBBER RESEARCH SCHEME (CEYLON)

LIST OF PUBLICATIONS FOR SALE.

Bulletins No. 1-20. Bound volume **Rs. 5-00. Later Bulletins Re. 1-00** per copy

No. 1. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 2. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 3. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis Part I.
No. 4. The Physiological Effects of Various Tapping Systems, Part I.
No. 5. Progress Report on Vulcanization Tests
No. 6. The Physiological Effects of Various Tapping Systems, Part II.
No. 7. Do Do Do Part III
No. 8. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis, Part II.
No. 9. Vulcanization Tests.
No. 10. Do.
No. 11. Variability in Rubber Manufacture.
No. 12. Progress Report of the Rubber Research Chemist.
No. 13. Vulcanization Tests.
No. 14. On the Variation in the Number of Latex Vessels present in Hevea brasiliensis.
No. 15. Vulcanization Tests.
No. 16. On the Natural Clotting of Rubber Latex.
No. 17. Vulcanization Tests.
No. 18. Measurements of "Bark Renewal."
No. 19. Vulcanization Tests.
No. 20. Do.
No. 21. Do.
No. 22. Do.
No. 23. Do.
No. 24. Do.
No. 25. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 26. Results of Trials of Ceylon Plantation Rubber for the manufacture of Ebonite.
No. 27. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 28. Do.
No. 29. Summary of the Principal Results obtained from Investigations into the Properties of Ceylon Plantation Rubber in relation to its Method of Preparation.
No. 30. The penetration of disinfectant on the tapping cut of Hevea brasiliensis.
No. 31. On the Occurrence of "Rust" on Sheet Rubber.
No. 32. On the Preservation of Latex.
No. 33. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 34. Do.
No. 35. Do.
No. 36. Do.
No. 37. Do.
No. 38. Do.
No. 39. Do. (Final Report Series I.)
No. 40. Do Series II.
No. 41. Do. First Interim Report on artificial ageing tests.
No. 42. On the Smoking of Sheet Rubber in relation to Mould Prevention.
No. 43. The inter-relationship of Yield and the various Vegetative Characters in Hevea brasiliensis. (out of print).
No. 44. The Construction of Smokehouses for Small Rubber Estates. (out of date).
No. 45. The Efficiency of Disinfectants and Fungicides.
No. 46. The Control of Bark Rot by Disinfectants.
No. 47. Report on Variability of Ceylon Estate Grades.
No. 48. Brown Bast and its Treatment.
No. 49. Report on Causes of Variation in Plasticity.
No. 50. Crepe Rolling.
No. 51. The Curing of Sheet Rubber.
No. 52. The Preparation of Uniform Rubber.

Booklets at Rs. 2-50 per copy.

Guide to the Preparation of Plantation Rubber, by T. E. H. O'Brien, M.Sc., A.I.C., Chemist.

The Budding of Rubber, by R. A. Taylor, B.Sc., Physiological Botanist. (out of date).

Diseases of Rubber in Ceylon, by R. K. S. Murray, A.R.C.Sc., Mycologist.

Copies of the following publications of the Rubber Research Institute of Malaya are available at the prices indicated:—

Planting Manual No. 4—Latex Preservation and Shipment **Rs. 3-50.**
" " " 5—The history and description of clones of Hevea Braziliensis. **Rs. 5-00.**